A Q U A P H Y T E

UNIVERSITY OF FLORIDA
Institute of Food and Agricultural Sciences

CENTER FOR AQUATIC PLANTS

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Army Corps Research in Lewisville, Texas

Just north of Dallas on the shores of Lewisville Lake is the Lewisville Aquatic Ecosystem Research Facility (LAERF), 110 acres including 55 research ponds, state-of-the-art laboratories, and outdoor environmental education areas for local school children. LAERF is operated by the U.S. Army Corps of Engineers Waterways Experiment Station (WES) under the Aquatic Plant Control Research Program (APCRP).

The Lewisville facility is where the Corps' aquatics researchers take the intermediate steps between tank-scale testing in the laboratory and large-scale testing in lakes, reservoirs and waterways. LAERF "allows us to do research we couldn't accurately do otherwise," said Mr. Lewis Decell, program manager of APCRP.

The chief of LAERF is Dr. Michael Smart, a Corps research biologist: "Here we can control just about everything but the weather on a realistic scale. We can also do long-term studies that are nearly impossible in the lab. We don't know of any large-scale research facility with the capabilities or potential of Lewisville."

The next generation is learning to appreciate the values of aquatic ecosystems thanks to extension scientists like the University of Florida's Dr. Charles Cichra (Fisheries) and Dr. Kenneth Langeland (Aquatic Plants). Here, as part of the 4-H Ecology Field Day, Cichra shows third graders in Madison (Florida) the kinds of small animals that live among aquatic plants. The classes took place in a pond at the Ladell Brothers Outdoor Environmental Center on the campus of North Florida Junior College.

LAERF is suitable for many kinds of studies having to do with aquatic plants and aquatic ecosystems. Its 55 ponds average seven feet deep and are one-half to two acres in size. Each pond can be filled or drained according to the needs of the researchers, and ponds are automatically monitored for water temperature and other variables. Its laboratories have the best equipment for analyzing plants, sediments and water. The facility includes a full weather station as well.

More than a dozen APCRP researchers use the facility, and are supported by laboratory chemists and other workers. The researchers are also assisted by a couple of dozen graduate students from several area colleges and universities who spend long hours monitoring, planting, harvesting, grinding, taking data and analyzing the results of the various experiments.

About 20 experiments are conducted at a time by researchers of the several "technology groups" of APCRP: the biological control, chemical control, simulation and ecology groups. Here are some experiments that are now underway in the LAERF ponds:

[See LAERF on Page 15]

THE LIMITS OF AQUATIC SYSTEMS

Aquatic scientists often compare the values of different aquatic variables they collect to those reported by scientists from other parts of the world. This fundamental exercise contributes to the knowledge of the ecological limits these variables can have. In addition, these comparisons often reveal interesting aspects (or inconsistencies!) in the data. When newly measured values are close to the minimum or maximum reported values, they indicate measurements that may need to be reexamined for correctness or they may add insight into the ecological functioning of particular systems.

Hence, we believe there is a need for a comprehensive compilation of published ranges of physical, chemical and biological variables that have been measured in rivers, lakes, wetlands and oceans. We have begun to organize these types of data and intend to publish the compilation in an appropriate journal for the general use of aquatic scientists throughout the world.

In exchange for free copies of the finished work, we ask for your help with this task.

If you have measured or know of a value for an ecological variable that may represent a high or low limit and can cite the work so that the scientific community can use it, please send the documentation of this value (date and location of sample, method, value, and citation) to us.

The following are partial lists of the types of values that we believe should be compiled:

Physical Properties
altitude
latitude
area
depth
residence time
sedimentation rate
current
turbulence
density
temperature
optical properties
etc.

Chemical Properties
salinity
specific conductance
conservative ion concentrations
nutrient concentrations
oxygen concentrations
dissolved organic carbon
etc.

Biological Properties
primary producers
(macrophytes, algae)
bacteria
protozoa
zooplankton
fish
amphibians
aquatic reptiles
aquatic birds
other aquatic wildlife:
biomass
metabolism
(respiration, photosynthesis)
immigration
reproduction
growth
recruitment
mortality
(natural, harvested)
emigration
etc.

510 (ug/L) Chlorophyll a

18 (kg wet wt/m^2), *Hydrilla verticillata*

0.77 (mm TL/day), Largemouth bass

We believe that with your help a completion date of 1996 seems reasonable. And we will make sure that all contributors get free copies of the finished product.

Thank you very much for your help.

1200 (µS/cm @ 25°C), Specific Conductance

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A T T H E C E N T E R

Phyllis Rester (directed by Ed Phlips, Fisheries and Aquatic Sciences) completed her master's degree with the thesis, *Algal Growth Response to Sediment Resuspension in a Shallow Subtropical Lake, Lake Okeechobee.* (Ms. Rester has the added distinction of completing her degree at the non-traditional age of 72.)

Janice Miller (directed by William Haller, Agronomy) completed her master's degree with *Autecological Studies of Southern Wild Rice (Zizania aquatica var. aquatica L.) in Florida.*

Melanie Moon (directed by George Bowes, Botany) completed her master's degree with *The Effect of Temperature on the Distribution, Physiology and Competitive Ability of Hydrilla verticillata and Egeria densa.*

Sherilyn Wood has stepped into the rather large footprints left by Philip Chiocchio after a five-year run as "video-man" at the Center for Aquatic Plants. Phil helped produce 18 educational videotape programs as part of the Center's Information Office. He now moves on to the Department of Computer Animation at the Ringling School of Art and Design in Sarasota, Florida.

Effect of 2,4-D...

In his master's thesis, *Effect of 2,4-D Amine on the Movement and Feeding Behavior of Largemouth Bass,* Marvin Boyer (directed by Charles Cichra, Fisheries and Aquatic Sciences) concluded that surface application of 2,4-D amine did not affect the home range, nesting, eating or other behaviors of largemouth bass.

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Acorus calamus, a medicinal aquatic

by V.V. Sivarajan, Professor, Department of Botany, University of Calicut - 673 635, Kerala, INDIA.

Commonly known as "sweet flag", *Acorus calamus* is a small, gregarious, rhizomatous herb growing in ditches, margins of lakes, streams and in marshes. Superficially resembling Iris and Gladiolus, sweet flag can easily be recognized by its characteristic smell, the typical aroid inflorescence and the absence of prominently colored flowers. A native of India and North America, sweet flag is now widely distributed and cultivated in various parts of Europe and Asia.

That the strongly scented, bitter rhizomes of this plant have been widely used in medicine and for other purposes is clear from ancient Indian writings and in those of Dioscorides, Avicenna and others. In America, they were once eaten as candy and its powder was chewed in the belief that it would help break habitual tobacco smoking. It was so important a merchandise in ancient America that some tribes used it as a medium of exchange. The American Indian used it against a variety of ailments. The drug was listed in the US Pharmacopoea until the US Food and Drug Administration reported that the Asian variety was found to produce cancerous tumors in experimental animals and consequently declared its use as "unsafe".

Acorus has been an important article of trade between India and Arab countries for a long time, possibly resulting in its introduction to West Asia and thence to Europe. It was the Tartars who first introduced *Acorus* to Poland. History has it that the entire stock of European *Acorus* originated from the famous botanist, Clusius, who cultivated it in Vienna in 1574, from a rhizome he procured from Asia minor and subsequently distributed to Belgium, Germany and France. It was later introduced to England in 1596 by Gerard. However the Indian rhizome continued to enjoy an edge over American and European stock because of its stronger and more agreeable odor and continued to be imported into Europe, even after it became common there.

Dioscoride's *Herbal* is ample proof that this drug was well known to ancient Greeks who used it widely in their medicines. In fact, the generic name, *Acorus*, is derived from "acoron" used by Dioscorides for the plant. This in turn was derived from the Greek, "coreon" (pupil of the eye), as it was used by the Greeks in treating ophthalmic complaints.

Europeans used sweet flag not only for medicinal purposes, but also for sanctifying places of worship and sometimes even private houses of the affluent. The chopped rhizomes were strewn on the floors of churches at festival times to impart a pleasant (celestial!) odor. In fact, Cardinal Wolsey of England had to face a charge of extravagance on this count, because in those days, England was importing *Acorus* at considerable expense.

In India, *Acorus calamus* has been used in indigenous medicine since ancient times, as can be seen in classical literature. Garcia da Orta, in his *Os Colloquios* (1565) discussed this drug and its importance in great detail. Indians used it against a variety of ailments and for improving digestion, speech and intelligence. It was considered to be useful in warding off evil spirits and to cure hysteria, insanity, epilepsy and chronic rheumatic complaints. But we Indians have also been cautioned that overdosage can lead to irrepressible vomiting. The maximum dose is 35 grains at a time.

Apart from these, this drug has been considered to be a good repellant of snakes and insects. Snake catchers and charmers are reported to chew the rhizomes before their encounters. And keeping bits of the rhizome or its powder in woolen clothes in wardrobes saves the clothes from insect damage.

Acorus rhizomes have been an integral part of Grandma's medicine chest in most Indian homes for centuries. It has been used to cure infantile problems and stomach complaints. In Kerala, it has been a long-standing tradition to rub the rhizome and gold on the tongue of new-born children. The gold, it is believed, imparts fair complexion to the baby and improves its intellect. *Acorus*, in its turn, wards off all other problems of health, besides curing fungal infections of the tongue, enabling the baby to start speaking rather earlier and more legibly too. Are mothers and would-be-mothers listening?

MEETINGS

14th INTERNATIONAL SYMPOSIUM OF THE NORTH AMERICAN LAKE MANAGEMENT SOCIETY. October 31-November 5, 1994, Hyatt Orlando Hotel, Orlando, FLORIDA.

The NALMS mission is "to forge partnerships among citizens, scientists and professionals to foster the management and protection of lakes and reservoirs for today and tomorrow."

The theme of this year's conference is "Managing Water Resources in the 21st Century: Finding Workable Solutions." This year's symposium will include a special session on "Managing Aquatic Macrophytes."

Abstracts are due June 1; address them to Marty Kelly, SW Florida Water Mgmt District, 7601 Hwy 301 N, Tampa, FL 33637. For other NALMS information, call 904/462-2554.

21st ANNUAL CONFERENCE ON WETLANDS RESTORATION AND CREATION. May 19-20, 1994, Sheraton Grand Hotel, Tampa, FLORIDA.

This annual conference provides a forum for nationwide exchange of results of scientific research in the restoration, creation and management of freshwater and coastal wetland systems. For information, contact F.J. Webb, Hillsbororugh Community College, Plant City Campus, 1206 N. Park Road, Plant City, FL 33566, 813-757-2104.

EWRS 9th INTERNATIONAL SYMPOSIUM ON AQUATIC WEEDS. September 12-16, 1994, Trinity College, Dublin, IRELAND.

The European Weed Research Society organizes this aquatic weed symposium every four years. As have the previous eight, the upcoming symposium relates to the biology, ecology, spread and control of aquatic weeds in temperate and tropical climates.

Of particular concern this time are the effects aquatic weeds have on the functioning of aquatic ecosystems, natural biological community processes and man's use of water. Scientists, engineers, managers, conservationists and environmentalists all will find a forum where they can meet in comfortable surroundings and exchange ideas.

For more information, contact Dr. Joe Caffrey, Central Fisheries Board, Mobhi Road, Glasnevin, Dublin 9, IRELAND.

RESTORATION OF AQUATIC ECOSYSTEMS: DEVELOPING A NATIONAL AGENDA. June 20-23, 1994, Radisson Hotel, St. Paul, MINNESOTA.

This meeting is sponsored by the U.S. Environmental Protection Agency, and is hosted by the Association of State Wetland Managers, the Coalition to Restore Aquatic Ecosystems, and the Coalition to Restore Urban Waterways.

The goal of the meeting is to "help develop a national agenda or strategy for facilitating the restoration of wetlands, streams, and lakes on a watershed basis at all levels of government and by the private sector in the U.S. and other countries."

For more information, contact the Association of State Wetland Managers, P.O. Box 2463, Berne, NY 12023-9746, 518/872-1804.

ECOSYSTEM MANAGEMENT AND RESTORATION FOR THE 21st CENTURY. October 19-22, 1994, Palm Beach Gardens, FLORIDA.

This is the 21st Natural Areas Conference and will have sessions on control of exotics; fire management; hurricanes; marine, wetland and old growth ecosystems; environmental education and mitigation banking.

To submit abstracts or obtain more information, contact E.S. Menges, Archbold Biological Station, P.O. Box 2057, Lake Placid, FL 33416-4680, 813/465-2571.

SHALLOW LAKES '95, International Conference on Trophic Cascades in Shallow Freshwater and Brackish Lakes. August 21-26, 1995. Mikolajki, POLAND.

This meeting continues the work of the international conference on shallow lakes held in Silkeborg, Denmark in 1992. It will cover all aspects of shallow lake research such as lake succession, nutrient dynamics, trophic relations, stable states, and bio-restoration practices.

The conference will be conducted in English and will be hosted by the Mikolajki Hydrobiological Station of the Institute of Ecology. It will be chaired by Lech Kufel, Andrzej Prejs and Jan Igor Rybak.

For more information, contact Lech Kufel, Institute of Ecology, PAS, Hydrobiological Station, Lesna 13 11-730 Mikolajki, POLAND.

BOOKS/REPORTS

DYNAMIC AQUARIA, Building Living Ecosystems by W.H. Adey and K. Loveland, Smithsonian Institution, Washington, D.C. 1991. 643 pp.
(Order from Academic Press, Inc., San Diego, CA 92101.)

This book contains information that enables scientists and hobbiests to build model aquatic ecosystems that closely approximate natural ecosystems.

It is divided into four broad sections of several chapters each. Part I discusses the physical environment, including shapes and construction materials for the aquaria, and the types of substrate to make up the floor of the system. Part II discusses the biochemical environment, including gas and nutrient exchange and animal waste management, and the use of "controlled communities of algae" to simulate larger volumes of open water. In Part III, the biological structure section, the role of diversity and the food web are discussed in terms of "aquarium science". In Part IV, the authors present case studies of microcosms, mesocosms and aquaria. And in Part V, they present "principles for establishing and operating living ecosystems."

PRIVATE LANDOWNER'S WETLANDS ASSISTANCE GUIDE: Voluntary Options for Wetlands Stewardship in Maryland, by U.S. Environmental Protection Agency, Wetlands Division. 1992. 39 pp.
(For information on the availability of this booklet, contact the Wetlands Protection Hotline, 800-832-7828.)

This guidebooklet was developed for Maryland workshops held in 1992, entitled "A Land Ethic for Wetlands Stewardship: Assisting Private Landowners to Conserve and Manage Wetlands." It was written for field staffs of federal, state and local agencies and organizations.

This guide lists public and private assistance programs which are available to provide financial and technical assistance to private homeowners and landowners who want to manage and retain the natural and cultural values of their property.

Programs provide technical assistance in wetlands creation and restoration; management of wildlife, forestry and agriculture; education and outreach opportunities; and financial incentives including cash benefits, cost-sharing, tax incentives and conservation management agreements.

Because the guidebook was made for Maryland residents, Maryland state programs are featured. However, much of the remainder of the booklet will be useful to residents of other states, inasmuch as the federal programs which are described and the discussions about landowner planning and general options apply to all U.S. citizens.

CHESAPEAKE BAY SUBMERGED AQUATIC VEGETATION HABITAT REQUIREMENTS AND RESTOR-ATION TARGETS: A TECHNICAL SYNTHESIS by R.A. Batiuk, R.J. Orth, K.A. Moore, et al., Chesapeake Bay Program, Annapolis, Maryland. 1992. 248 pp.
(For information, contact Richard A. Batiuk, U.S. Environmental Protection Agency, Chesapeake Bay Program Office, Annapolis, Maryland.)

One of the world's largest estuaries, Chesapeake Bay, suffers from a seriously reduced abundance of submersed aquatic plants. Historically, some twenty freshwater and marine species have provided food for waterfowl and habitat for shellfish and finfish, and have affected nutrient cycling, sediment stability and water turbidity. It is believed the decline is a result of the development of the bay's shoreline and surrounding watershed.

The objective of this "technical synthesis" is to present the water quality standards required to support continued survival, propagation and restoration of submersed plants in the bay. Using "nutrient and sediment reduction strategies", bay managers expect to restore submersed aquatic plants to hundreds of thousands of hectares of bay bottom.

The authors say this synthesis is the "first comprehensive effort to link habitat requirements for a living resource with water quality restoration targets for an estuarine system."

EDIBLE? INCREDIBLE! POND-LIFE, The Eating Guide To American Ponds, by M. Furlong and V. Pill, 1980, 95 pp.
(Order from Naturegraph Publishers, Inc., Box 1075, 3543 Indian Creek Rd., Happy Camp, CA 96039. US$7.95 plus postage.)

This interesting little "cookery" book includes recipes for beverages, muffins, jellies, salads and main dishes, which are made from grasses and herbs, trees and shrubs, and animals of the ponds of North America. Among the aquatic plants called for are arrowheads, burreeds, cattails, lilies, pondweeds, reed grass, rushes, sedges, watercress and wild rice. Each plant is pictured and characterized; edible parts are briefly described. One plant recipe is for a sedge-nut energy bar, another for arrowhead/burreed salad.

PLANTES SAUVAGES DES LACS, RIVIERES ET TOURBIERES, Guide d'identification, by Groupe Fleurbec, Quebec, Canada, 1987. 400 pp.
(Order from Fleurbec, Saint-Henri-de-Levis, Quebec, G0R 3E0, CANADA. US$20.00 plus shipping.)

This highly informative field guide to aquatic plants includes the most comprehensive treatments of any aquatic plant field guide in the APIRS library. If the reviewer could read French, he would buy a copy of this excellent book for personal use.

Several pages are devoted to each plant, and include sections about its Latin name, synonymy and etymology; its origin and world distribution; a map of its North American distribution; its detailed description; other plants that it might be confused with; its flowering period; its habitat; its toxicity; its medicinal use; its edibleness; and its horticultural and agricultural interest. Each plant is also pictured in a full-page color photograph, and a supplemental photograph.

Fleurbec, the private non-profit group of researchers, writers and photographers, is well-known for its series of wildflower books, of which this is one.

RESTORATION OF AQUATIC ECOSYSTEMS, Science, Technology and Public Policy, by the U.S. National Research Council, Washington, DC, 1992. 552 pp.
(Order from Island Press, Box 7, Covelo, CA 95428. Hardcover, US$39.95 plus S/H.)

The Committee of eminent scientists that wrote this report on restoration ecology believes that "whereas much about the functioning of ecological systems remains poorly understood, it is common to fail to use even available information when attempting to solve environmental problems."

Therefore, this report is an attempt to present the basics of what is known about aquatic restoration, and to expound the basic elements of a national restoration strategy.

It includes sections on the history and government control of ecosystem management; planning and evaluating aquatic ecosystem restoration; overviews of lakes, rivers and wetlands ecosystems and restoration, including needs and recommendations; national restoration goals, and several case studies of restorations of lakes, rivers and wetlands.

WETLAND PLANTING GUIDE FOR THE NORTHEASTERN UNITED STATES, Plants for Wetland Creation, Restoration and Enhancement, by G.A. Thunhorst, Environmental Concern, Inc. 1993. 179 pp.
(Order from Environmental Concern, Inc., P.O. Box P, 210 West Chew Avenue, St. Michaels, Maryland 21663. US$19.95 plus S/H.)

Made for wetland designers, "this guide is an effort to consolidate the information available from many different sources on wetland species...It is hoped the guide will prevent the placement of species in areas where they cannot compete or survive."

The guide includes trees, shrubs, and herbaceous emergent, submersed, and floating vegetation. A single standardized page is devoted to each of about 150 plants, and includes a plant drawing, and basic characteristics about plant type, growth, planting spacing, habitat, wildlife benefits and required hydrology. The book includes a list of wetland plant suppliers.

This is the most thorough wetland/aquascaping plant guide known to APIRS.

WETLANDS, 2nd edition, by W.J. Mitsch and J.G. Gosselink. 1993. 722 pp.
(Order from Van Nostrand Reinhold, Mail Order Dept., P.O. Box 6904, Florence, KY 41022-9949, 1-800-544-0550. US$59.95 plus S/H.)

This is a new edition of one of the definitive books on the subject of wetlands, authoritatively written by two recognized wetlands ecologists. The book is readable, suitable for many audiences, well-organized and illustrated with photographs, understandable graphics, and useful charts.

In this fine book are reviews about wetland history, types, terms, hydrology, biogeochemistry, biological adaptations and wetland ecosystem development. The authors also present overviews of coastal wetlands, including tidal saltwater and freshwater marshes, and mangrove wetlands; as well as overviews of inland wetlands, including freshwater marshes, northern peatlands, southern deepwater swamps and riparian wetlands.

The book concludes with an overview of the management of wetlands, including the valuation of wetlands, protection, creation and restoration and classification and inventory of wetlands.

ECOLOGICAL INTEGRITY AND THE MANAGEMENT OF ECOSYSTEMS, edited by S. Woodley, G. Francis and J. Kay. 1993. 220 pp.
(Order from St. Lucie Press, 100 E. Linton Blvd., Suite 403B, Delray Beach, FL 33483. US$59.95 plus $5.95 S/H.)

The first paragraph from the first chapter, "The Notion of Natural and Cultural Integrity," by H.A. Regier:

"The notion of ecosystem integrity is rooted in certain ecological concepts combined with certain sets of human values. The relevant normative goal of human-environmental relationships is to seek and maintain the integrity of a combined natural/cultural ecosystem which is an expression of both ecological understanding and an ethic that guides the search for proper relationships."

LAKE TITICACA, A Synthesis of Limnological Knowledge, edited by C. Dejoux and A. Iltis. 1992. 573 pp.
(For the U.S.A. and Canada, order from Kluwer Academic Publishers, 101 Philip Drive, Norwell, MA 02061. US$239.00 plus S/H.)

Lake Titicaca is a huge and deep lake, the highest navigable lake in the world (at 12,500 feet). It is part of the border between Bolivia and Peru. This book is a compilation of more than a century of limnological work done on the unusual lake, a lake that has long been known for its reported *lack* of biological diversity, as well as its alleged high degree of endemism (species known only from Lake Titicaca).

The book has sections on the lake's origins; geomorphology and sedimentation; paleohydrology; climatology and hydrology; physico-chemistry; phytoplankton; macrophytes; zooplankton; benthic fauna; fish fauna; associated animal communities; ethnology and socio-economy; hydrological potential, ichthyological potential and its contamination.

As for macrophytes, the lake has notably few species. A band of tall totoras (*Schoenoplectus tatora*) is obviously prominent, and the submersed plants *Elodea potamogeton* and *Myriophyllum elatinoides* are very abundant. Lake Titicaca also features *Lemna gibba*, *Ruppia maritima*, *Zannichellia palustris*, *Ranunculus trichophyllus*, *Hydrocotyle ranunculoides*, *Azolla filiculoides* and a species or two of *Potamogeton*. Only a dozen aquatic plant species have been recorded there.

HARMFUL NON-INDIGENOUS SPECIES IN THE UNITED STATES, U.S. Congress, Office of Technology Assessment. 1993. 400 pp.
(Order from New Orders, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954. US$21.00; International customers, add 25%.)

The Foreword of this report states that "...federal and state policies designed to protect us from the worst [non-indigenous] species are not safeguarding our national interests in important areas"--there is no real national policy, the current system is piecemeal, statutes and regulations do not keep pace with new pests, better environmental education would help, and greater funding for faster response is needed.

This report to Congress is a very good (and relatively readable) overview of the problems caused by non-indigenous species ("NIS"), and a frank assessment of the failures of federal and state laws and regulators. The authors present options for improving regulations and make recommendations.

[See BOOKS on page 8]

[BOOKS, from page 7]

In its review of the worst NIS in the U.S., the authors found that 79 of 557 NIS had caused an estimated cumulative loss of about $97 *billion*. The report attributes almost 96% of this loss to exotic insects, and less than 1% to aquatic weeds.

As an example of the kinds of regulatory problems that persist, the authors noted that purple loosestrife (*Lythrum salicaria*), Brazilian pepper (*Schinus terebinthifolius*) and Eurasian watermilfoil (*Myriophyllum spicatum*), are not listed on the current federal list of noxious weeds, and thus still may be legally imported.

EVERGLADES, The Ecosystem and Its Restoration, edited by S.M. Davis, J.C. Ogden and W.A. Park. 1994. 826 pp.
(Order from St. Lucie Press, 100 E. Linton Blvd., Suite 403B, Delray Beach, FL 33483, (407) 274-9906. US$97.50 plus $7.95 S/H)

This is a collection of 31 review articles, including unpublished data, about various aspects of the Everglades, from the driving forces that formed them, to the vegetation and faunal components and processes that characterize them, to guidelines for restoring them to the way they were before being drained, ditched and diked, poked, plugged and plowed.

Among other chapters in this book, there are reviews about the history of Everglades water control and agriculture; the age and evolution of the 'glades in terms of sea level, climate, hydrology and fire patterns; vegetative composition, patterns and sensitivity to nutrients; and the population dynamics of fish, alligators, wading birds and white-tailed deer.

The most interesting chapter has to do with the Natural System Model, a computer simulation (being developed by the South Florida Water Management District) of how water might flow in a natural Everglades, having no canals, structures, pumps, etc. Accompanying colored plates show that surface water flow would be more extensive and prolonged in the Everglades were it not for canals, roads and other man-made structures.

VERNAL POOL PLANTS, Their Habitat and Biology, edited by D.H. Ikeda and R.A. Schlising, Studies from the Herbarium, California State University, Chico. Number 8. 1990. 178 pp.
(Order from Studies from the Herbarium, Department of Biological Sciences, California State University, Chico, CA 95929-0515. $11.00. Make checks to: The University Foundation.)

This is a collection of eight papers given at the 1989 symposium designed to emphasize biological and environmental information on the plants of vernal pools. "Vernal pools are characterized by "long-term or periodic inundation during the growing season, desiccation during the summer and early fall, and a flora dominated by native annual species adapted to both aquatic and terrestrial habitats and the added stress of year-to-year climatic differences."

Papers in this collection discuss the floristics of volcanic vernal pools, the edaphic factor in plant community patterns, a model of the hydrology of vernal pools, the structure and function of photosynthetic tissues of vernal pool macrophytes, host-specific bees, plant life histories and vernal pool restoration and creation.

INVASIVE PLANTS OF NATURAL HABITATS IN CANADA, by D.J. White, E. Haber and C. Keddy, Canadian Wildlife Service. 1993. 121 pp.
(Order from Habitat Conservation Branch, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario K1A 0H3, CANADA.)

Alarmed by the rapid spread of the exotic wetland plant, purple loosestrife (*Lythrum salicaria*), Environment Canada contracted this study. It documents the occurrence of invasive wetland and upland plant species of Canada. The study also presents a thorough review of the federal weed acts of Canada, and suggests modifications to them.

Of an estimated 700 alien plant species in Ontario, the "principal aquatic aliens" are few and include Eurasian watermilfoil (*Myriophyllum spicatum*), European frog-bit (*Hydrocharis morsus-ranae*), flowering rush (*Butomus umbellatus*), glossy buckthorn (*Rhamnus frangula*), purple loosestrife (*Lythrum salicaria*) and reed canary grass (*Phalaris arundinacea*). Some minor invasives include curly pondweed (*Potamogeton crispus*), floating heart (*Nymphoides peltatum*), marsh cress (*Rorippa amphibia*), and yellow flag (*Iris pseudacorus*).

EARTHKIND - ROMANIA SEEKS CONTRIBUTIONS

Located in the center of Bucharest, a city of two million people including 100,000 students, is the newly established **Public Information and Documentation Environmental Center** (PIDEC) of EarthKind-Romania, a professional non-profit non-governmental organization founded last October as a branch of EarthKind International.

The main objectives of EarthKind are biodiversity and wetlands conservation, environmental education and management, and improving public awareness of environmental problems. The main goal of PIDEC is to provide access to information on the environment, both at a general level and at a higher scientific level.

Due to the destruction of the university library in December 1989 and the lack of large collections on environmental topics in Bucharest public libraries, there is a great need for periodicals and books on environmental sciences. Several thousand books and journals have been donated and some funds have been received from the Regional Environmental Center for Central and Eastern Europe, the EEC and from UNESCO for subscriptions.

However, additional support is requested in acquiring recent books and textbooks on ecology and environmental sciences and in subscribing to journals.

For further information, contact Dan Cogalniceanu, Coordinator, PIDEC, University of Bucharest, Faculty of Biology, Splaiul Independentei 91-95, 76 201 Bucharest, Romania. Telephone/Fax: 4013122310.

FROM THE DATABASE

Here is a sampling of the research articles, books and reports which have been entered into the aquatic plant database since November, 1993.

The database has more than 37,000 items. To receive free bibliographies on specific plants and/or subjects, contact APIRS at the address shown on the mail label on page 16.

To obtain articles, contact your nearest state or university library.

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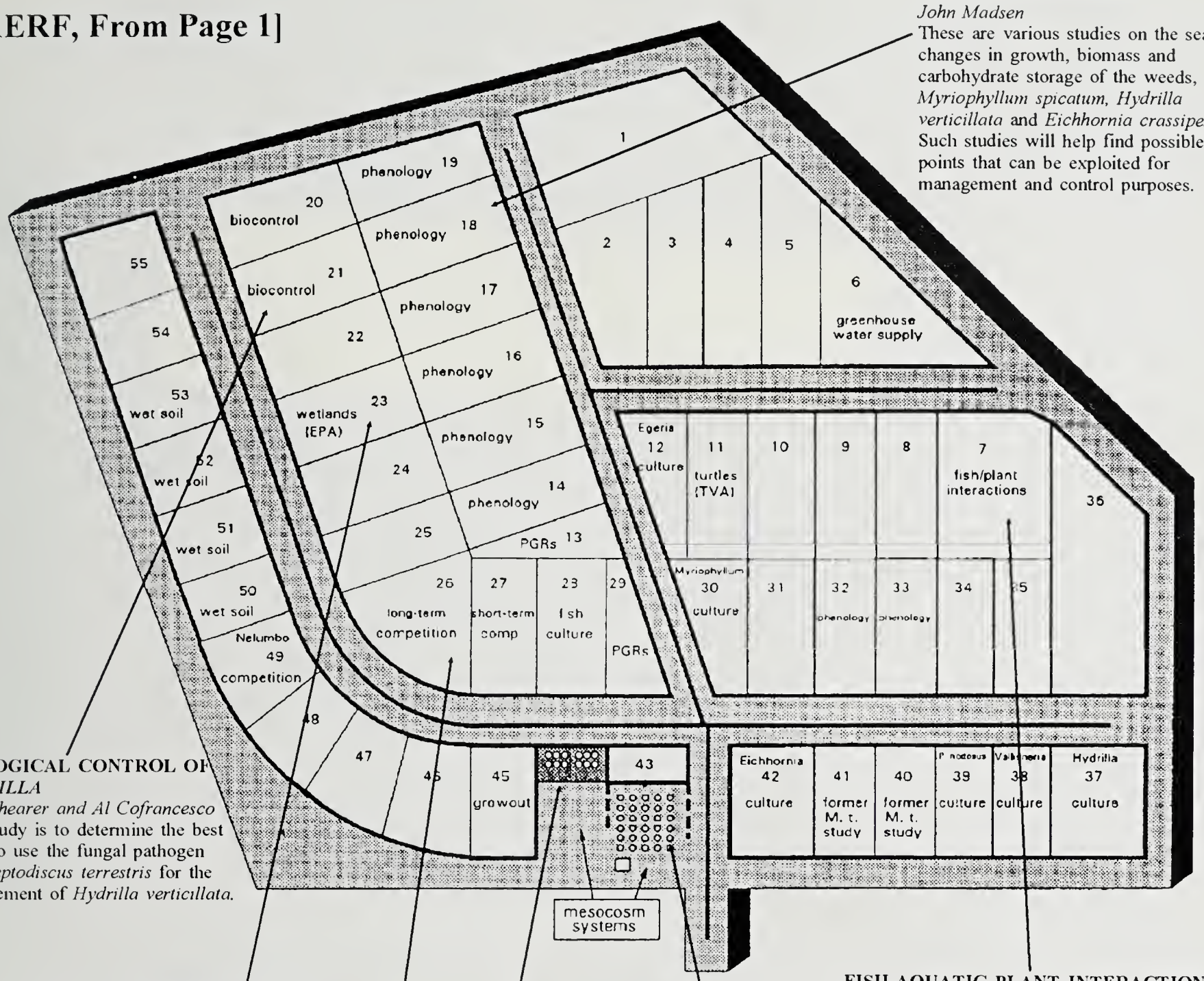
[LAERF, From Page 1]



PHENOLOGY STUDIES
John Madsen
These are various studies on the seasonal changes in growth, biomass and carbohydrate storage of the weeds, *Myriophyllum spicatum, Hydrilla verticillata* and *Eichhornia crassipes*. Such studies will help find possible weak points that can be exploited for management and control purposes.

BIOLOGICAL CONTROL OF *HYDRILLA*
Judy Shearer and Al Cofrancesco
This study is to determine the best ways to use the fungal pathogen *Mycoleptodiscus terrestris* for the management of *Hydrilla verticillata*.

EFFECTS OF HYDROLOGY ON PLANT ESTABLISHMENT
Robert Doyle
This study examines the effects of five hydrologic regimes on the establishment of six species of wetland plants. This team also studies the fate of agricultural herbicides in wetlands.

PLANT GROWTH MODELS
Michael Stewart
These are very deep, planted tanks for studies of light penetration into water and growth effects of various light regimes on *Myriophyllum spicatum* and *Hydrilla*.

PLANT GROWTH REGULATORS (PGRS)
Kurt Getsinger and Linda Nelson
Seeking species-selective herbicidal control, these are very large tank ("mesocosm") studies on the effects of various rates of herbicides (flurprimidol and triclopyr) on target aquatic weeds and native aquatic plants.

FISH-AQUATIC PLANT INTERACTIONS
Eric Dibble and Jack Killgore
This study investigates the influence of different submersed plants on the growth and behavior of juvenile largemouth bass (*Micropterus salmoides*). The plants under study are *Hydrilla verticillata, Myriophyllum spicatum*, and *Potamogeton nodosus*.

LONG- AND SHORT-TERM COMPETITION STUDIES
Michael Smart
Long-term: Examines competitive interactions among native plants, *Vallisneria americana* and American pondweed (*Potamogeton nodosus*), and the exotic *Hydrilla verticillata* to assess the ability of the two natives to resist invasion by the exotic.
Short-term (seasonal): Evaluates competition between the beneficial native plant, water star grass (*Heteranthera dubia*), and the exotic *Hydrilla verticillata*.

For more information about LAERF, write:
Dr. R. Michael Smart
Research Team Leader
Lewisville Aquatic Ecosystem Research Facility
RR3, Box 446
Lewisville, TX 75056-9720

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AQUAPHYTE

This is the newsletter of the Center for Aquatic Plants and the Aquatic Plant Information Retrieval System (**APIRS**) of the University of Florida Institute of Food and Agricultural Sciences (IFAS). Support for the information system is provided by the Florida Department of Environmental Protection, the U.S. Army Corps of Engineers Waterways Experiment Station Aquatic Plant Control Research Program (APCRP), and IFAS.

EDITORS: Victor Ramey
Karen Brown

AQUAPHYTE is sent to 5,000 managers, researchers and agencies in 87 countries. Comments, announcements, news items and other information relevant to aquatic plant research are solicited.

Inclusion in *AQUAPHYTE* does not constitute endorsement, nor does exclusion represent criticism, of any item, organization, individual, or institution by the University of Florida.

50% RECYCLED

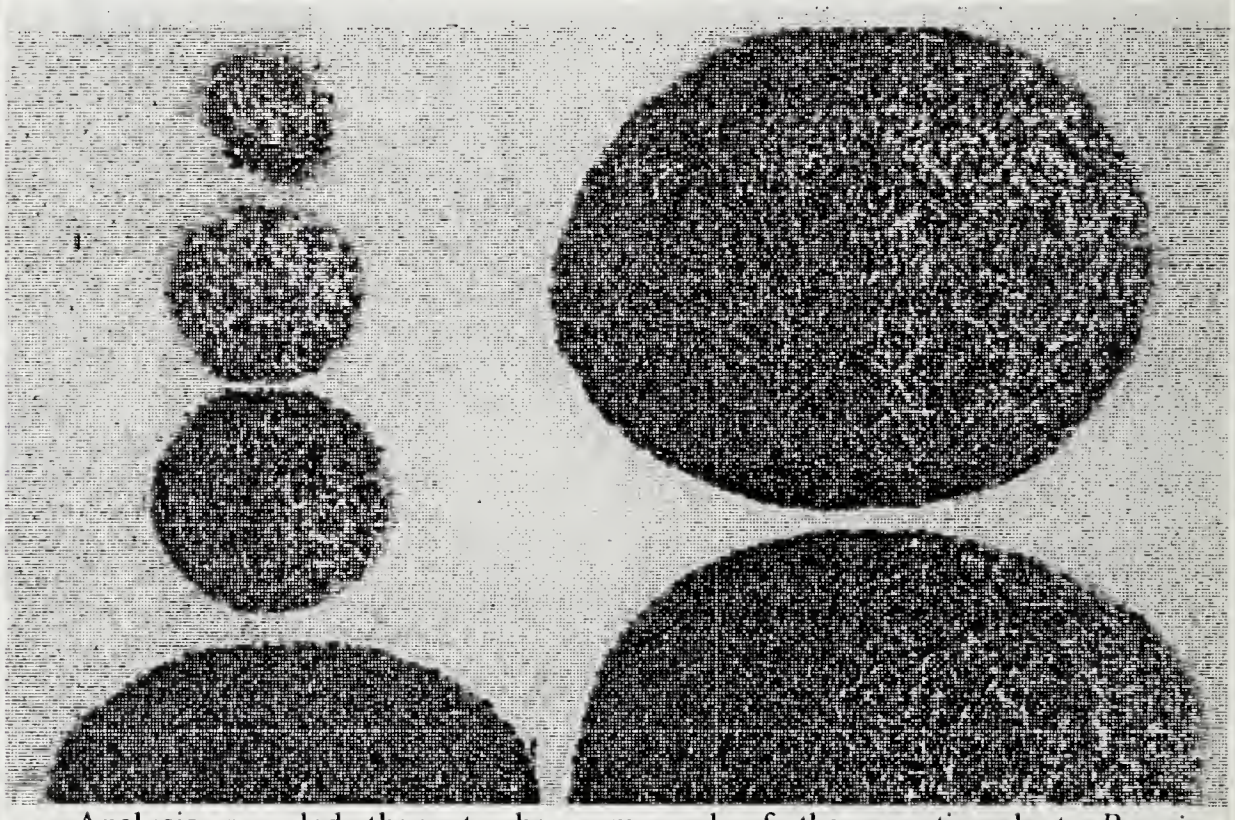
What Are These?

In 1947 a man took a box full of strange-looking balls to the University of California (Berkeley) for identification. The balls were regularly oval in shape, gray in color, and appeared to be composed of a hairlike substance. They were relatively hard and varied in size from a baseball to a small watermelon.

Cut into cross sections, they revealed a tightly-packed matrix of small, stiff, woody, needlelike fibers nearly uniform in length.

Thousands of the balls were found on the shores of brackish Little Borax Lake, near Mount Konokti in California. Most of the balls appeared to be new, some appeared to be years old.

What were they?



Analysis revealed them to be composed of the aquatic plant, *Ruppia maritima*. Scientists conjectured that the balls were made from the loose *Ruppia* plants being rolled by wave action along the shallow shore line.

For more information, see *The Ruppia balls of Little Borax Lake*, by E.O. Essig, Sci. Monthly 66:467-471, 1948.

A Q U A P H Y T E

UNIVERSITY OF FLORIDA
Institute of Food and Agricultural Sciences

CENTER FOR AQUATIC PLANTS

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Aquatic Plant Encrustations

You look into a Florida lake and ask, "Why aren't the plants green? What are the submersed plants covered with?" The answers given for the past 100 years have been, they're covered with "marl" or "carbonates", but nobody really knew for sure. A University of Florida benthic ecologist *did* want to know for sure, but could find little published research about the kinds of minerals that encrust submersed macrophytes.

Dr. Paul Zimba (UF Fisheries and Aquatic Sciences) undertook to identify which minerals encrust submersed plants in Florida. He reported his findings to the EWRS (European Weed Research Society) 9th International Symposium on Aquatic Weeds in Dublin in September.

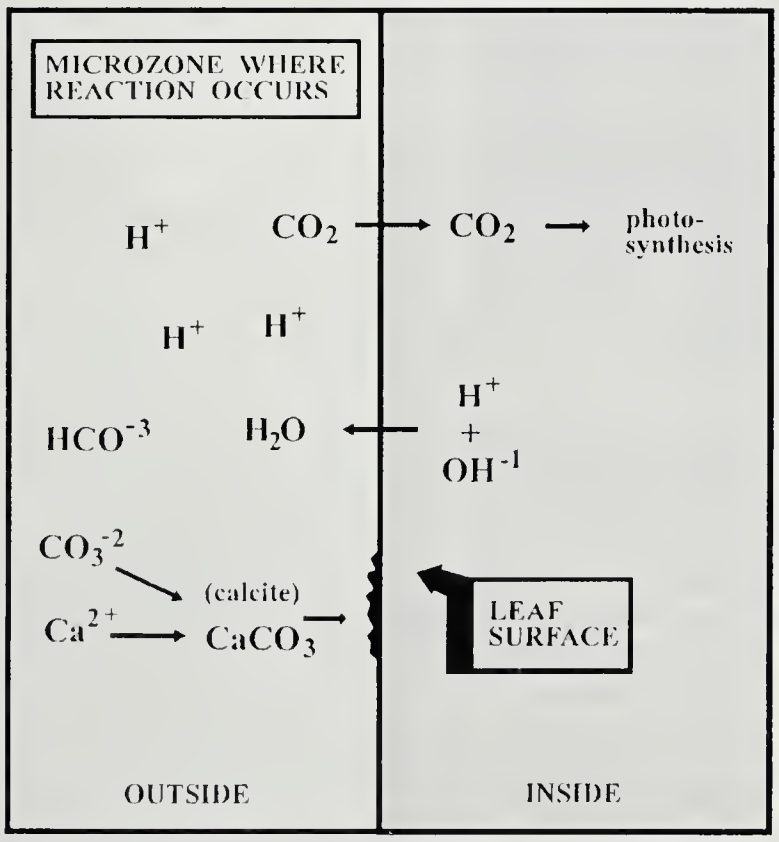
Encrustation of submersed macrophytes results from photosynthesis, sinking of dead plankton, sediment resuspension and growth of attached biota. Zimba sampled submersed plants from 18 Florida lakes, (oligo- to hyper-eutrophic) and analyzed the encrusted materials on the leaves of 11 underwater species.

Previous research (in temperate lakes) found calcite (calcium carbonate having hexagonal crystals) to be the predominant form of carbonate formed in freshwater systems. In the present study, calcite also was most common, found on plants in 12 of the 18 lakes.

However, Zimba identified other plant-encrusting minerals: biotic and sand silica was abundant on plants in some lakes; the iron oxide, hematite, was found on the plants of another lake; and the "marl" on plants in other lakes was found to consist of sodium chloride (table salt) and sylvite (potassium chloride).

Now we know that submersed plant encrustations in Florida are not always calcite. In some lakes, the encrustations may be comprised of silica, hematite, sodium chloride or potassium chloride.

How are encrustations formed as a result of plant photosynthesis?



Intensive plant photosynthesis depletes available CO_2 in the water. The photosynthetic cycle pumps hydrogen ions into the water, thus shifting the pH of the microzone of water surrounding the leaf to basic conditions. Basic conditions favor the pricipitation of dissolved mineral salts onto the leaf surface.

Development of Constructed Wetlands in Slovenia

Dr. Dani Vrhovsek[1], Tjasa Bulc[2]

1 Independent researcher, Pozarnice 41, 61 357 Notranje Gorice, 61 000 Ljubljana, Slovenia
2 Water Management Institute, Hajdrihova 28, 61 000 Ljubljana, Slovenia

Constructed wetlands offer an effective and economical solution to the growing problems of environmental pollution. They are simple in concept, inexpensive to construct and easy to operate. Constructed wetlands are built as a part of the natural local environment which they successfully preserve by protecting it against pollution.

The research group of the Water Management Institute has since 1989 designed and built seven constructed wetlands on the territory of Slovenia. They were installed to treat domestic sewage, waste waters from food processing plants, landfill leachate and to further clean waste waters from conventional treatment plants. Field analysis and operation experience have shown that constructed wetlands are

[See WETLANDS on Page 14]

INTERNET ACCESS

Yes, E-mail can be sent to the Aquatic Plant Information Retrieval System (**APIRS**) through INTERNET:

VARAMEY@NERVM.NERDC.UFL.EDU

Plants Poster

APIRS has given away 5,000 copies of the *Freshwater Plants* poster (left) to teachers, libraries and environmental agency trainers in Florida. Many more people still want it.

Therefore, APIRS seeks a sponsor to pay for its re-printing. (The funding sponsor's name and logo will be conspicuously added to the front of the poster.)

The illustration shown is a line drawing of the poster which, when printed, is **full-color** and **2 ft. X 3 ft. in size**. It is suitable for framing or tacking to the wall

.The poster depicts 63 aquatic plants in a typical natural setting, and shows their common and scientific names.

If you would like to receive a copy, or multiple copies, please let the APIRS office know. Such requests should make it easier for us to find a sponsor to pay for re-printing.

APIRS, Victor Ramey, 904/392-1799.

MEETINGS

SHALLOW LAKES '95, International Conference on Trophic Cascades in Shallow Freshwater and Brackish Lakes. August 21-26, 1995. Mikolajki, POLAND.

This meeting continues the work of the international conference on shallow lakes held in Silkeborg, Denmark in 1992. It will cover all aspects of shallow lake research such as lake succession, nutrient dynamics, trophic relations, stable states, and bio-restoration practices.

The conference will be conducted in English and will be hosted by the Mikolajki Hydrobiological Station of the Institute of Ecology. It will be chaired by Lech Kufel, Andrzej Prejs and Jan Igor Rybak.

For more information, contact Lech Kufel, Institute of Ecology, PAS, Hydrobiological Station, Lesna 13 11-730 Mikolajki, POLAND.

THE ECOLOGY OF LARGE RIVERS, First International Symposium. April 18-22, 1995. Krems, AUSTRIA.

The main sessions of this symposium are: community and population ecology in rivers, process studies, river hydraulics and sediment transport, production in larger rivers, large river research case studies, a poster session and two workshops to incorporate the comments of session chairmen.

The program is being organized by the Austrian Committee of the International Association on Danube Research, the Freshwater Biological Association and the Danube University Krems. It will be held on the grounds of Danube University.

For more information, contact Austrian Committee of the International Association on Danube Research, c/o G. Burget, Schiffmulenstrasse 120; A 1220 Wien, AUSTRIA: 234591/15.

SOUTHEASTERN LAKES: EXPECTATIONS AND OPPORTUNITIES, 4th ANNUAL SOUTHEASTERN LAKES MANAGEMENT CONFERENCE. March 30-April 1, 1995. Charlotte, North Carolina.

This conference is about everything having to do with southeastern US lakes: watershed management, water supply, non-source pollution, GIS, modelling, fisheries, aquatic plants, associations and volunteer monitoring. It will include talks, workshops, special programs and exhibits.

For more information, contact Barbara Wiggins, Mecklenburg Co. Environmental Protection, 700 North Tyron Street, Suite 205, Charlotte, NC 28202-2236, 704/336-5500.

AT THE CENTER

Flies on the Move

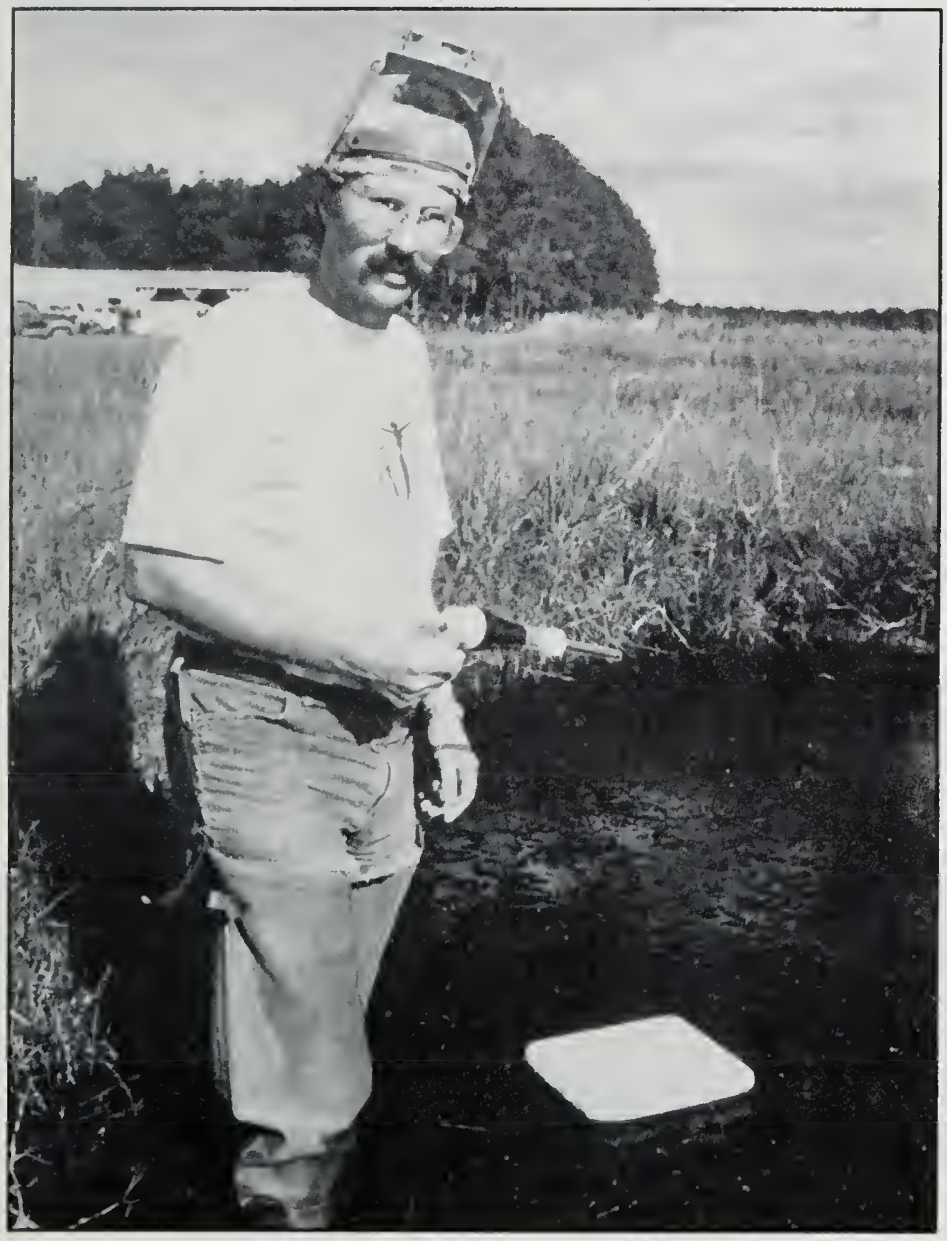
Biocontrol researchers in Florida believe that the hydrilla-eating fly, *Hydrellia pakistanae*, has dispersed and established throughout the state, after being released for biocontrol purposes only a couple of years ago.

Now the questions are, How much impact are the flies having on these vexatious plants? How many flies per square meter are needed to control heavy hydrilla growths under Florida's natural conditions? How much do predation, parasitism and other natural mortality factors affect the spread and abundance of the flies?

In a replicated study of uncovered ponds full of hydrilla, **Dr. James Cuda** is working to answer these questions. In the three-year study, Cuda will investigate the efficacy of single- vs. multiple-releases of the fly, and will quantify the damage *Hydrellia* is causing hydrilla. In cooperation with USDA and Corps of Engineers researchers, he will develop better procedures for sampling and monitoring the flies, and will determine better ways to detect damage caused by larvae and adults in the field.

Cuda is a research entomologist with the UF/IFAS Department of Entomology and Nematology. His work is funded through the Center for Aquatic Plants (Dr. William Haller, Interim Director), under a Cooperative Agreement between the Center and the U.S. Department of Agriculture.

Dr. Cuda (below) may be reached at Entomology and Nematology, University of Florida, POB 110620, Gainesville, FL 32611-0620, 904/392-1901.



After twelve years of dedicated leadership as director of the Center for Aquatic Plants and five years as director of the Center for Natural Resources, **Dr. Joseph Joyce** has been promoted to the position of UF/IFAS Associate Vice President for Agriculture and Natural Resources.

Congratulations, Joe.

A search is underway for a new director for the Center for Aquatic Plants.

Dr. Kenneth Langeland, aquatic plant researcher, university professor and Extension specialist, usually has his hands full. Here he examines filamentous algae growing in the culture tanks at the Center.

Langeland may be reached at the Center at the address below.

CENTER FOR AQUATIC PLANTS
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Dr. William Haller, Interim Director

Harvesting and Drying Hyacinths the Natural Way

The Castillero Lagoon is a natural floodplain of the Orinoco River in Venezuela, having a surface area of about 140 hectares. The climate is biseasonal, having dry and wet seasons. During the wet season (April to September), the Castillero Lagoon fills and reconnects to the Orinoco River. During the dry season, the lagoon loses water and becomes isolated from the river.

Water hyacinth (*Eichhornia crassipes*) is a common plant of the lagoon, having suddenly become extensive in the late 1970s. It is believed that the increased growth of the plant is due to overflowing wastewater tanks of the nearby town into the river.

Researcher Rodriguez Reyes and his colleages at the Universidade de Oriente Instituto Limnologico have found that the numbers of water hyacinth plants in the lagoon can double in seven days, and hyacinth weight can double in 10 days. The net productivity is 18 $g/m^2/day$, dry weight.

During the wet season, large dense rafts of water hyacinths are blown in amongst the trees and bushes of the lagoon, which during dry times are well up on shore. During the dry season, the water recedes, leaving thousands of tons of water hyacinths high and dry.

Composting

To researchers and locals who wanted to improve the acid soils of their gardens and fields, this seemed a useful resource free for the taking. So for the past several years they have gathered tons of the naturally dried and freely accessible water hyacinths for their favorite compost recipes. These formulas include blends of chopped dried hyacinths, cow manure, sawdust and phosphatic rock.

Unlike other ventures in which using hyacinths as soil amendments has been "uneconomical", the entrepreneurs at Castillero have found composting profitable. That's because nature and the fluctuating Castillero Lagoon have eliminated the usually prohibitive production costs of harvesting and drying the water hyacinth plants.

To help create micro-enterprises in the area, Rodriguez and colleagues are preparing a technical packet about water hyacinth composting in Venezuela.

For more information, contact Julio Rodriguez Reyes, Limnological Institute, Orient University, Caicara del Orinoco, Estado Bolivar, Venezuela.

Aquatic and Wetland Plant Identification Instruction

115 plant ID segments on 7 videotapes, in ordinary language

All for $105.00, plus tax; or they may be borrowed for free

Floating and Floating Leaved; Submersed; Emersed; and Grasses, sedges and rushes

(*To purchase:* call IFAS Publications, 904/392-1764. *To borrow:* call the APIRS office, 904/392-1799.)

The following is a pitch to get the reader to either buy or borrow the above-characterized videotape programs. Thousands of people have already done so.

Many professions require knowledge of aquatic and wetland plant species. Besides public and private aquatic plant managers, there are fish and other aquatic resource managers and regulators, pond builders, aquascapers, landscape architects, departments of transportation, ports-of-entry inspectors, volunteer lake management groups and others. In addition, science and environment teachers, and school students everywhere want to know more about their aquatic environments, including how to identify the most common aquatic plants that they see every day.

Many of you have attended field courses which show you how to identify aquatic and wetland plants. The tuition for these courses typically range in the several hundreds of dollars. Add to this the cost of travel and per-diem. The price may exceed $1000.00 per person, for basic aquatic plant identification training.

While of course such in-the-field training is invaluable, it still remains difficult to retain all the facts necessary to identify an appreciable number of wetland plants. This is only natural. The conditions of in-the-field identification courses are not always conducive to standing still, taking notes, making sketches, and memorizing, what with all the mosquitoes emerging from the shallow water and biting your netherparts. After "memorizing" several plants, your systems yell "overload!".

On the other hand, this invaluable field experience can be augmented by the use of simple, stay-at-home devices such as VCRs. It *is* possible to learn a great deal about aquatic plants by watching videos.

Our seven videotapes contain 115 segments about aquatic (which includes "wetland") plants. Each plant identification segment lasts about two minutes. First during a viewing session, the user or instructor, using a reference card, decides which plants to learn about and where the plants are located in the series. (We recommend your viewing only a few plant segments at a time; one can remember only so much at one sitting...)

A typical trainer or user might decide to view the watermilfoils in the second submersed videotape. There, users will get information common to all milfoils in general, and he'll get specific, if somewhat less than "botanical", identification instruction about three kinds of milfoils.

Or the user may want to receive a very quick general refresher on the identification of grasses, sedges and rushes. (What the #$%@ is a ligule?) There, in colorful, moving videotape, you'll see exactly what the ligule is and easily learn where to find it.

Thousands of trainers and personal users have borrowed and bought videotapes from the Aquatic and Wetland Plant Identification series. Call either of the numbers above for more information.

WHAT'S AN FAEP?

FAEP stands for **Florida Association of Environmental Professionals**, a non-profit organization which is a state chapter of a larger organization known as the National Association of Environmental Professionals (NAEP). NAEP and its chapters are all non-partisan professional groups, dedicated to the promotion of the highest standards of ethical practice and technical competency for all its members. Since its inception in 1975, NAEP has been recognized as one of the leading organizations among environmental professionals of all disciplines.

NAEP's interdisciplinary focus brings together nearly 4,000 members representing government, consulting, academe, industry and the private sector in the U.S. and abroad. They work in all areas of air, water, noise, waste, ecology and education. NAEP's affiliate organization, the Academy of Certified Environmental Professionals, awards the peer-reviewed "Certified Environmental Professional (CEP)" designation to those professionals working in the field who have met stringent requirements for technical competency and professional conduct. Other membership benefits include "The Environmental Professional", a peer-reviewed journal, and the "NAEP News", a bimonthly newsletter.

State chapters, such as FAEP, provide a forum for professionals to network and address the concerns and issues specific to their own geographical regions. Within FAEP there are six chapters, with two more under development. These local chapters hold monthly meetings, conduct technical seminars and participate in public service projects such as beach restorations.

For additional information about membership or upcoming events, contact Ms. Donna Carter, FAEP Membership, 6524 Ramoth Dr., Jacksonville, FL 32226-3202 or call 904/251-2360.

WEEDS 2.0, A Computerized Way To Identify 970 Weeds

WEEDS is the **W**estern **E**xpert **E**ducational **D**iagnostic **S**ystem. Its purpose is to enable non-botanists to identify 970 important weed species of the western U.S. by use of a computer. Because a computer is involved, the user has the choice of randomly using many characteristics for "keying out" a plant, rather than using only two already-chosen characteristics as in traditional dichotomous keys.

The publication includes a computer database and interactive identification program (on disc, only for IBM compatibles, DOS 3.0, 400K RAM or better), and a hard-copy **User's Guide**.

One also must have an illustrated identification handbook such as *Weeds of the West* (T.D. Whitson, editor, published by the University of Wyoming) to make this system completely useful.

This program is not "user-friendly" in the way Windows and Macintosh users have come to know the term. But it *is* "straight-forward": it is a DOS text-only database operated by the keyboard--white on blue, no fancy interface, no need for a mouse, no "windows", no icon graphics, no color photographs, not a plant line drawing to be found. According to the **WEEDS** people, they are working on the next version, which will be for the Windows environment and may feature a fancy interface and mouse-use.

To use this or any identification system, one must know the terminology. In the case of **WEEDS 2.0,** the user must refer back to the printed User's Guide to view the many line drawings of possible leaf shapes, petal tips, carpel separations, blade surfaces, etc. Or the user may press F2 for written descriptions of all terms. Of course, non-botanists will constantly refer to the Guide to key out a plant, just as they must when using traditional dichotomous keys: Petal tips erose? Carpels united? Fruit a pepo? Surface tomentose?

Once the user has followed the computer program and the User's Guide as far as she can, she presses F6 to see the final list of plant species. This final list refers back to another section of the User's Guide, where other lists refer the user to page numbers in 11 regional weed manuals and 4 floras. It is in these separate books that you'll find "the rest of the story": the photographs, drawings, descriptions, etc., that you typically want to see and read after keying out plants.

WEEDS 2.0. The cost is $85.00 ($65 with educational discount) for the disc and User's Guide. **Order from Weed Diagnostic Lab, Department of Plant, Soil and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339; 208/885-7831.**

The companion book, *Weeds of the West,* may also be ordered from the same address for $19.50.

El-Fish, El-Reality

This is about an educational computer "game" that *does* have something to do with aquatic plants. **El-Fish** is an "electronic aquarium" (IBM 386 & above, or MAC versions, 4 MB RAM, VGA/SVGA, mouse, hard disk).

On the computer screen, El-Fish lets you build an almost-photo-quality-high-resolution aquarium, and stock the aquarium with fish, plants, rocks and assorted electronic equivalents of aquarium doo-dads such as ceramic mermaids and sunken ships. The program comes packaged with dozens of aquatic plant types and shades, many rock shapes and textures, and many doo-dads. They all can be sized and placed anywhere on the bottom of the electronic aquarium.

But, the best part is the fish. Using the button of a mouse, you can catch, breed, evolve and animate your very own fish, and then place them into your electronic aquarium. In the aquarium, the electronic fish that you have made will swim so realistically, to and fro, that you will be surprised. Even the fish scales glow irridescently as the fishes turn. This program makes your home and office PCs do things you are not likely to have seen them do before.

The quality of El-Fish is very high. Its operation is intuitive. Its end results are very appealing and interesting.

Without reading the instructions, my 8-year-old daughter, Ana, operates most of the program without assistance. She especially enjoys creating new shapes, sizes and colors of fish. Using the game's excellent menu screens, she is able to make the fish evolve or breed, resulting in new kinds of fish. For example, from the program's Breed Fish Screen, she chooses the parent fish that are likely to produce offspring with the looks she wants: she "selects" for changes in the offspring such as larger fins, thinner fish, or brighter colors. Computer-breeding the offspring takes a basic computer setup at least a couple of minutes.

Playing with **El-Fish** is a fascinating learning experience that is recommended to serious teachers and students, as well as to people who want to *play with* their computers occasionally. According to the publisher, the idea of **El-Fish** was conceived by two Russians in 1988: Dr. Vladimir Pokhilko, a psychologist and software designer at Moscow University, and Alexey Pajitnov, a mathematician. Their "Human Software" is meant for "people's souls", they say.

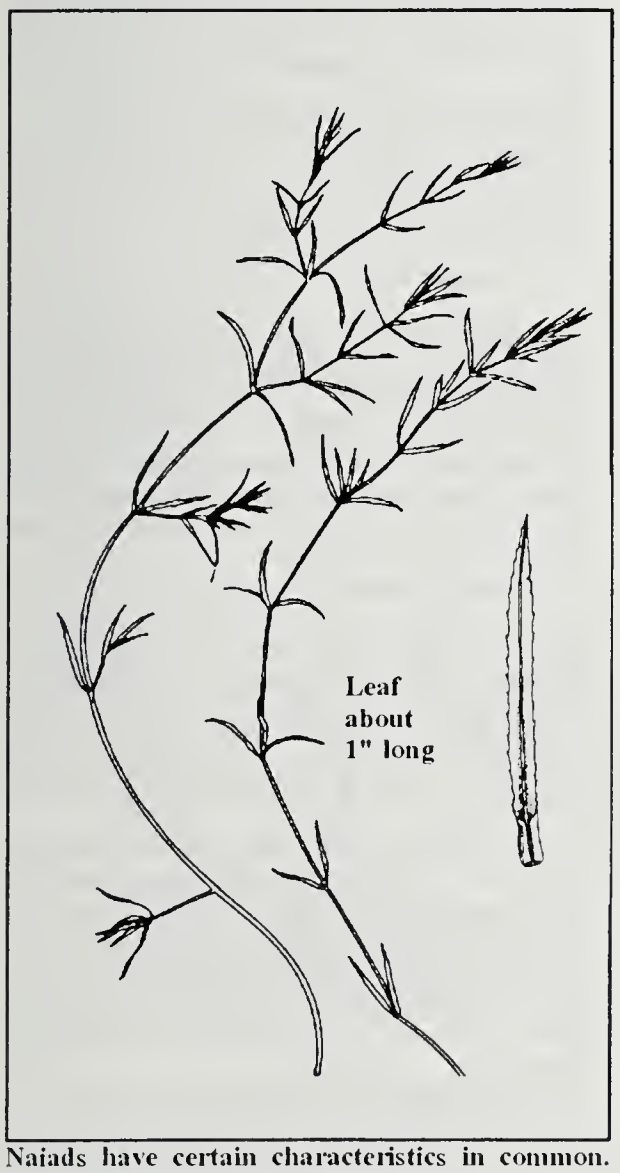
For more information, contact Maxis, 1-800-336-2947. DOS or MAC versions (no Windows version), $39.95. *V.R.*

Getting to Know the Natives

THE "OTHER" NAIADS IN FLORIDA

by **K. Craddock Burks, Botanist,** Bureau of Aquatic Plant Management, Florida Department of Environmental Protection, 3917 Commonwealth Blvd., MS 7105, Tallahassee, FL 32399-3000, 904/487-2600.

Most aquatic plant managers in Florida are familiar with the submersed plant, the common naiad (***Najas guadalupensis***). This native is frequent in lakes and rivers throughout much of the United States, Central America and the Caribbean. Probably less familiar, though, are the few other uncommon species of naiad that occur in Florida.



Naiads have certain characteristics in common. This drawing is of *Najas guadalupensis.*

There are about 40 Najas species world-wide, and all have certain characteristics in common: all are submersed; some form surface mats in Florida; all leaves are small (1" long or less) and strap-shaped with pointed tips; and with a hand lens, margin teeth are visible on the leaves. Naiad stems are long, thin and much-branched. Naiad flowers are inconspicuous.

Five of the nine naiad species known for North and Central America have been found in the Sunshine State. Besides *N. guadalupensis*, they are:

Najas marina, the spiny naiad, has been seen in a handful of coastal counties from the panhandle to south Florida, and in a saltwater spring of the interior north central region. It is well adapted to brackish and highly alkaline waters and is easily recognized by the large teeth on the leaf-blade margins, with similar-size prickles on the back of the main leaf veins and on the stems. It also has the largest fruits of our naiads.

Najas wrightiana, Wright's naiad, is the smallest and most rare of our "other" naiads. The Florida populations, known only from fringes of the Big Cypress Swamp, are at the northern edge of the species' circum-Caribbean range. Its small size makes it difficult to spy; quite possibly it occurs in additional swampy locations in Florida. The tiny leaves tend to cluster at the ends of the delicate short stems. Each leaf has a long narrow toothed blade that abruptly expands into a short toothed leaf base (leaf "sheath").

The one exotic (non-native) species of naiad that has been documented in Florida is ***Najas minor***, the small naiad. It has been occasionally reported in Florida, but the only report confirmed by herbarium specimens is from Lake Seminole, a large reservoir in the panhandle. A native of Eurasia, small naiad is thought to have been introduced from Europe into the northeastern (U.S.) states about 50 years ago and since has expanded west to the Ohio and Mississippi River systems. This plant apparently does well in eutrophic waters. *N. minor*'s light green leaves are about the same length as those of *N. guadalupensis*, but more narrow and more obviously toothed along the margins. The leaf base, or sheath, is distinctive, the top being flat or slightly lobed where it joins the blade.

Some of the unconfirmed survey reports for the exotic small naiad plant may actually have been misidentifications of the rare native, ***Najas filifolia***, or slender naiad. Since the slender naiad has been recognized as a rare native, it has become a candidate (Category II) for listing under the U.S. Endangered Species Act. (For such candidates, there is some evidence of their vulnerability to extinction, but not enough information is yet available to decide on listing them.)

This species is known only from six localities in Florida and south Georgia. Two recent collections from Lake and Highland counties (Florida) have extended its known range into central peninsular Florida. The slender naiad has spreading, toothed leaves similar to *N. minor*, but the leaves are usually darker green, or sometimes reddish, and generally smaller.

The rare native, *Najas filifolia.*

The one feature unique to *N. filifolia* is its curved fruit. Unlike any other naiad on the continent, it has slender cylindrical fruits whose tips are directed horizontally. This character created earlier confusion about the plant's identity--it was once thought to be the Japanese plant, *N. ancistrocarpa*, whose fruits are curved nearly into a horseshoe shape.

Of course, all of Florida's native naiads are targets for protection in aquatic plant management. Not only do they contribute to our natural diversity of plants, but also they provide habitat and food for invertebrates and fish. Naiads in particular are important food sources for waterfowl such as ducks.

For more, contact the address above.

BOOKS/REPORTS

A NATURALIST IN FLORIDA, A Celebration of Eden by A. Carr, edited by M.H. Carr, with a forward by E.O. Wilson. Yale University Press. 1994. 264 pp.
(Order from Yale University Press, PO Box 209040, New Haven, CT 06520-9040, 203/432-0940. $28.50 plus S/H. ISBN 0300055897.)

As almost all nature-readers know, Archie Carr has as much respect for his audience as he has for his work--so he tells us about the good things he observes as well as the bad, and lets *us* weigh them and come to our own conclusions as to the imminence of Armageddon.

This book (his last, compiled and edited by widow Marjorie Carr) is a diverse collection of stories and essays written during a lifetime of discovery and teaching in Florida. It includes stories about a Gulf of Mexico island that's covered with deadly bird-eating, fish-eating water moccasins; about the habits of a 'gator that lived in his backyard for 40 years; about the meaning of "jubilees" of animals in roadside ditches; about "cut-bait fishermen" who use dynamite; about why Peninsula cooters lay triple-clutches of eggs; about the "melancholy mischief" of armadillos in Florida... Other stories are about hunting; about optical illusions in pinewood forests; about Spanish moss; about hammocks, flatwoods and marshes; about how carnivorous plants work... One chapter discusses water hyacinths: it is "more than a mere blight on southern waters. It is a plant of surpassing ecological interest."

In the final chapter, *Eden Changes*, Carr expounds on the "bright spots in our relationship with natural Florida"; how we are beginning to eschew the teachings and wanton exploitation of the "fast-money chaps" in favor of establishing laws and conservation measures which so far have led to the gradual replenishing of alligators, manatees, otters, beavers and wading birds. And, Carr points out, a Florida traveler today sees a "far greener and more opulent country than what they used to see from the Model T Fords." Carr says the "new stewardship...brings promise of better times for man and nature in Florida."

Of the many "must-read, save Florida" books that are out there, this is among the very best. Carr's love of Florida and love of language make this a thoroughly readable book--an environmental and scientific classic that may be appreciated by anyone.

HANDBOOK OF COMMON FRESHWATER FISH IN FLORIDA LAKES by M.V. Hoyer and D.E. Canfield, Jr., Fisheries and Aquatic Sciences, University of Florida. 1994. 177 pp.
(Order from IFAS Publications, IFAS Bldg 664, Gainesville, FL, 32611-0001, IFAS # SP-160; 904/392-1764.)

Here is an interesting idea for what to do with years of research data that is "hidden in filing cabinets, gray literature and the minds of the workers": compile a book. In this particular case about freshwater fish, everyone's a winner: the researchers/authors get to organize their file drawers and notes and prove to everyone that they've been working hard all along; the needy field biologist in charge of lake management gets much real-world information in a convenient and usable form; and the interested citizen gets a handbook full of fish-facts that ordinarily couldn't be found in three or four expensive Audubon-type books.

In this 8 X 10 book, each of 39 most common fish of Florida lakes is treated with a line drawing, a color photo, and information including fish description and distribution, biology, biologist comments and a review of the Florida data.

In addition, statistical tables for each fish show statistics for lake morphology, water chemistry and aquatic macrophyte variables, population estimates for the fish, and various statistics about size and weight.

One long table in the book is particularly interesting for purposes of comparing fish species according to environmental variables. Table 4 rank-lists fish species presence according to lake surface area, mean depth, pH, total alkalinity, specific conductance, water color, total P, total N, chlorophyll *a*, secchi depth, and percent area covered with macrophytes.

A GUIDE TO AQUATIC PLANTS: Identification and Management by D.F. Fink, Minnesota Department of Natural Resources, St. Paul. 1994. 52 pp.
(Order from Ecological Services Section, Minnesota Department of Natural Resources, 500 Lafayette Road, St. Paul, MN 55155-4025, 612/296-2835.)

This 7" X 10.5" handbook was created for lake users in Minnesota. Besides having an identification section for 25 common aquatic plants, it briefly describes the ecology of, the benefits of and the problems caused by aquatic plants. This includes relevant state laws, and outlines the ins and outs of aquatic plant control and the permitting process in Minnesota.

The booklet also lists and answers the most commonly-asked questions about aquatic plant management, and includes a directory of government offices and a reference list of books.

BIOLOGICAL CONTROL OF WEEDS: SOUTHEAST ASIAN PROSPECTS by D.F. Waterhouse, Australian Centre for International Agricultural Research, Canberra, Australia. 1994. 302 pp.
(Order from ACIAR, 3rd Floor, 10 Moore Street, Canberra, ACT 2601, Australia. (06) 248-8588.)

The purpose of this book is to "summarise for the [27] major exotic weeds of agriculture in Southeast Asia what is known about their natural enemies and the prospects for classical biological control."

This list of major agricultural pests includes several aquatic plants. The author concludes that 6 of the plants have good to excellent prospects for biological control and that 6 more are likely to have valuable natural enemies. There exists insufficient information to classify the remaining 15 major pest plants.

Each plant is treated with a line drawing, an Asian distribution map, and text as to its common names, origin, distribution, characteristics, importance and natural enemies.

WEEDS OF THE WEST by T. Whitson, L. Burrill, S. Dewey et al, Western Society of Weed Science. 1992. 630 pp.
(Order from Weed Diagnostic Lab, Department of Plant, Soil and Entomological Sciences, University of Idaho, Moscow, Idaho 83844-2339, 208/885-7831. $19.50.)

This thick paper-back book was published by the Western Society of Weed Science in cooperation with the Western United States Land Grant Universities Cooperative Extension Service. It includes 300 species of 51 plant families. A key to the families is included.

Each plant treatment includes full color photographs, one full page mature plant and two smaller photos of close-up distinguishing characteristics. The text includes a basic morphological description and a short paragraph about the plant's distribution, flowering, etc. The book presents no control information.

It can be used with the computer program WEEDS 2.0, reviewed on page 6.

WETLANDS AND ECOTONES: Studies on Land-Water Interactions, edited by B. Gopal, A. Hillbricht-Ilkowska and R.G. Wetzel. 1993. 301 pp.
(Order from International Scientific Publications, 50-B Pocket C, Siddhartha Extension, New Delhi 110014, INDIA. US$40.00.)

Wetlands "include a large diversity of habitats such as freshwater and salt marshes, swamps and mangroves, bogs and fens, shallow lakes, lagoons, temporary ponds, fish ponds and aquaculture systems as well as the littoral zones of lakes, riparian habitats in the river valleys and vast floodplains of large rivers as well as their deltas, and many others."

Ecotones are "the tension zone where principal species from adjacent communities meet their limits" (Clements, 1905), or the "zone of transition between adjacent ecological systems, having a set of characteristics uniquely defined by space and time scales and by the strength of the interactions between adjacent ecological systems" (Holland, 1988).

Are *wetlands* also *ecotones?* R.W. Tiner of the U.S. Fish and Wildlife Service writes: "The concept of ecotones has been overstated and, in many cases, misapplied to wetlands...Wetlands are no more ecotones than other habitats...The concept of ecotones is best applied to individual plant communities rather than to broad habitat types such as wetlands."

This book is a collection of 21 papers given at the International Conference on Land-Water Interactions held in New Delhi, December 8-14, 1991.

WATERPLANTS IN AUSTRALIA– A Field Guide, 3rd edition, by G.R. Sainty and S.W.L. Jacobs, Royal Botanic Gardens, Sydney. 1994. 327 pp.

(Order from Sainty and Associates, P.O. Box 1219, Potts Point N.S.W., AUSTRALIA, 2011; 02/332-2661. $29.95 plus S/H.)

This is a unique pocket-sized identification book which describes 120 water plants. It also has chapters on algae and management. Color photographs and drawings of special features accompany descriptive notes about each plant.

A useful feature of this book is its extensive use of color-coded drawings which are keys to the growth habits, leaf shapes and leaf arrangements of the plants.

VOLUNTEER ESTUARY MONITORING: A Methods Manual, by N.A. Fisher, U.S. Environmental Protection Agency, Oceans and Coastal Protection Division. 1994. 176 pp.

(Order from Alice Mayio, USEPA, Assessment and Watershed Protection Division (4503F), 401 M Street SW, Washington, DC 20460; 202/260-7018. Free.)

Since 1987, the EPA has supported the use of citizen-volunteers in the monitoring of the nation's lakes and rivers. Research shows that the data collected by these concerned citizens is generally of high quality and is reliable. The work done by volunteers is work that financially-strapped government agencies have come to rely on.

Now the EPA uses volunteers to monitor estuaries. This well-organized, cleanly-designed and readable handbook provides step-by-step instructions for volunteers to take and report useful measurements of dissolved oxygen, nutrients and phytoplankton, submersed plants, bacteria, debris and shellfish.

A CITIZEN'S MANUAL FOR DEVELOPING INTEGRATED AQUATIC VEGETATION MANAGEMENT PLANS, by M.V. Gibbons, H.L. Gibbons and M.D. Sytsma, prepared for Washington State Department of Ecology. 1994. 50 pp.

(Free. Order from Ms. Kathy Hamel, Coordinator, Washington State Department of Ecology, Freshwater Aquatic Weeds Management Program, P.O. Box 47600, Olympia, WA 98504-7600, 206/407-6562.)

This is a step-by-step instruction manual for defining your lake management problems, identifying management goals, involving the public, collecting data, identifying beneficial use areas, mapping and describing aquatic plants, investigating and specifying a control method and control intensity, and implementing the plan.

The authors optimistically specify the steps for solving aquatic plant management problems, but make it clear throughout that "it is crucial to recognize the uniqueness of each body of water, and that there is no quick fix that covers every situation."

LAKESMARTS, The First Lake Maintenance Handbook--A Do-It-Yourself Guide to Solving Lake Problems, by S. McComas, produced by the Terrene Institute, Washington, D.C.

(Order from LakeSmarts, c/o 550 Snelling Avenue South, Suite 105, St. Paul, MN 55116, 800/743-3456. $18.95 per copy, plus $3 s/h.)

This understandable, illustrated book describes more than 100 techniques to solve specific problems in water management: how to save that tree from falling down the eroded embankment; how to reduce the number of stunted bluegill in an overstocked pond; how to build a one-man harrow for harvesting submersed weeds...

These "lake maintenance projects are designed to fill the gap that is not covered by lake restoration and management programs...The guidelines I use to qualify real lake maintenance projects can be summarized in six words: safe, cheap, environmentally sound and simple. Not all projects in this handbook fit these guidelines, but most do."

Chapters are about aquatic weed control, algae control, fish topics, sediment topics, on-site wastewater treatment systems, and additional lake projects.

BIOLOGICAL STUDIES OF *BAGOUS HYDRILLAE*, by G.R. Buckingham and J.K. Balciunas, U.S.Department of Agriculture, for the U.S. Army Corps of Engineers. 1994. 50 pp.

(Order from Reports and Distribution, US Army Corps of Engineers, Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, 601/634-2571. Technical Report A-94-6.)

This is the final report of the study of *Bagous hydrillae* (formerly, *B. australasiae*), a small Australian weevil that extensively damages hydrilla in its native environment. This report gives the taxonomy, distribution, host plants, life history, mortality factors, effects on host plants, and the weevil's potential control value. The authors believe that *B. hydrillae* "has the potential to greatly increase the stress on hydrilla in southern states where hydrilla is most abundant."

ECOLOGY AND MANAGEMENT OF INVASIVE RIVERSIDE PLANTS, edited by L.C. de Waal, L.E. Child, P.M. Wade and J.H. Brock, Landscape ecology series. 1994. 217 pp.

(Order from John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158, 212/850-6336. $95.00.)

"Landscape ecology concerns the inter-relationships between the various components of the landscape--flora, fauna, soil, water and air."

This first volume in Wiley's Landscape Ecology Series, a workshop Proceedings, reviews in detail the biology and autecology of five diverse invasive species: *Crassula helmsii* (swamp stonecrop), *Impatiens glandulifera* (Himalayan or Indian balsam), *Fallopia japonica* (Japanese knotweed), *Heracleum mantegazzianum* (giant hogweed) and *Tamarix* (salt cedar).

The book includes 20 chapters by some of the most respected plant ecologists of Europe.

FIELD GUIDE TO COASTAL WETLAND PLANTS OF THE SOUTHEASTERN UNITED STATES, by R.W. Tiner, drawings by A. Rorer, U. Mass Press. 1993. 329 pp.

(Order from The University of Massachusetts Press, P.O. Box 429, Amherst, MA 01004, 413/545-2219. $17.95 plus S/H.)

This is a field guide to the coastal wetland plants of the South Atlantic and Gulf coasts (from Virginia to Florida and west to Texas). More than 250 plants are described and illustrated, and another 200 are cataloged as similar species. The drawings are simplified, emphasizing the easy-to-see characteristics of each plant.

The author also presents a succinct yet highly informative overview of coastal wetland ecology, including describing the eight major types of coastal wetlands and their indicator plants in the Southeast.

THE EVERGLADES HANDBOOK–Understanding the Ecosystem, by T.E. Lodge with an introduction by Marjory Stoneman Douglas, St. Lucie Press. 1994. 228 pp.

(Order from St. Lucie Press, 100 E. Linton Blvd., Suite 403B, Delray Beach, FL 33483; 407/274-9906. $29.95 plus tax and S/H.)

This easy-to-read reference addresses the questions people ask most about Florida's Everglades: where did it come from, what kinds of plants and animals live there, etc. In this book, the Everglades' plants and animals are covered in detail, and their interrelationships and functional roles within the system briefly explained; history, climate and hydrology are described; and a short-term prognosis and a long-term view of what will happen are offered.

This book would be appreciated by anyone interested in the 'glades, but might be best suited as a textbook for a high school Everglades appreciation course. The author's casual style brings to life dozens of ecological terms and concepts.

AQUATIC PLANTS OF JAPAN by Y. Kadono, Kobe University, 1994. 179 pp. (In Japanese)

(Order from Bun-ichi Sogo Shuppan, Co., Ltd, 13-10, Nishigokencho, Shinjuku-ku, Tokyo, 162, JAPAN. approx. $150, plus S/H. ISBN-4-8299-3034-9)

This book treats more than 200 aquatic plants of Japan. It is a large format book (8.5" X 12") and is beautifully designed and exceptionally clearly printed on heavy weight paper. It includes hundreds of very high-quality color and B/W photographs, including a few very interesting micrographs, as well as distribution maps for each species.

Various plant family sections of the book include descriptions of the plant family as well as brief descriptions of plant species occuring in Japan. For example, the pondweed family section, Potamogetonaceae, includes brief morphological descriptions, color photographs, line drawings and distribution maps of each of Japan's 29 species of pondweeds.

FROM THE DATABASE

Here is a sampling of the research articles, books and reports which have been entered into the aquatic plant database since March, 1994.

The database has more than 39,000 items. To receive free bibliographies on specific plants and/or subjects, contact APIRS at the address shown on the mail label on page 16.

To obtain articles, contact your nearest state or university library.

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Pistia stratiotes L. (Araceae), une adventice aquatique en extension vers le nord du Togo.
ACTA BOT. GALLICA 140(1):91-95, 1993.

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Acidification, growth promoter and red light effects on germination of skotodormant seeds of *Hygrophila auriculata.*
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Andersson, S.
Unequal morph frequencies in populations of tristylous *Lythrum salicaria* (Lythraceae) from southern Sweden.
HEREDITY 72(1):81-85, 1994.

Backeus, I.
Ecotone versus ecocline: Vegetation zonation and dynamics around a small reservoir in Tanzania.
J. BIOGEOGRAPHY 20(2):209-218, 1993.

Balciunas, J.K.; Bowman, G.J.; Edwards, E.D.
Herbivorous insects associated with the paperbark *Melaleuca quinquenervia* and its allies: I. Noctuoidea (Lepidoptera).
AUST. ENT. 20(1):13-24, 1993.

Bornette, G.; Amoros, C.; Collilieux, G.
Role of seepage supply in aquatic vegetation dynamics in former river chanels: Prediction testing using a hydroelectric construction.
ENVIRON. MANAGE. 18(2):223-234, 1994.

Bridges, E.L.; Orzell, S.L.; Burkhalter, J.R.
Cladium mariscoides (Cyperaceae) in the western Florida panhandle and its phytogeographic significance.
PHYTOLOGIA 74(1):35-42, 1993.

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Occurrence of *Anacharis alsinastrum* (*Udora canadensis*) in the Trent near Burton-on-Trent.
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The identification of Potamogetonaceae fruits found in the Netherlands.
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Relative role of different types of aquatic plants in the production of Mansonia.
J. COMMUNICABLE DISEASES 20(3):202-208, 1989.

Chick, J.H.; Jordan, F.; Smith, J.P.; McIvor, C.C.
A comparison of four enclosure traps and methods used to sample fishes in aquatic macrophytes.
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Establishment from leaves and other plant fragments produced by the foraging activities of geese.
FUNCT. ECOL. 6:297-301, 1992.

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The functioning of plant roots in the root-zone wastewater treatment plant.
IN: SBORN. UCELOVE KULTIVACE VODNICH A MOKRADNICH ROSTLIN, H. CIZKOVA-KONCALOVA AND S. HUSAK, EDS., TREBON, PP. 70-74, 1994. (In Czech.)

Coquery, M.; Welbourn, P.M.
Mercury uptake from contaminated water and sediment by the rooted and submerged aquatic macrophyte *Eriocaulon septangulare.*
ARCH. ENVIRON. CONTAM. TOXICOL. 26(3):335-341, 1994.

Cox, P.A.; Balick, M.J.
The ethnobotanical approach to drug discovery.
SCI AM 270(6):82-87, 1994.

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BOT. REV. 4:235-272, 1938.

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Ellis, L.L.
Preliminary notes on the correlation between alkalinity and the distribution of some free-floating and submerged aquatic plants.
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[WETLANDS, from Page 1]

efficient and economical in treating domestic sewage and waste waters from food processing plants. The range of potential applications for the constructed wetlands may be broadened through an appropriate assortment of aquatic plants and through minor modifications of wetland design.

Slovenia is a small country that bridges the shortest distance between the Mediterranean and the Alps. Slovenia has little over two million inhabitants that managed through generations to preserve their national identity while integrating with their neighbors (Italians, Austrians, Hungarians, Croatians). The country occupies only 20,000 sq. km, half of it covered by woods and forests, and has more than 70 plants unique to its area. Triglav, the highest mountain in Slovenia, in ancient times symbolized a three headed God--one for ruling the Sky, the second the Earth and the third the Underground. And it indeed seems that Slovenia exists on these three levels: above the mountain sky, through the green forests and blue waters in the more than 15,000 underground caves.

Some areas of Slovenia are experiencing a rapid decline in the quality of rivers, drinking water sources, lakes and fresh water reservoirs due to rapid development and industrial growth. Certain activities are to a great extent overloading surface waters and their self-cleaning abilities. At the same time, expensive conventional wastewater treatment plants are frequently inefficient due to pollution overload, inefficient planning, or inappropriate maintenance. Therefore, we are attempting to develop simpler, more efficient alternative methods of treatment.

At the beginning of the 1970s, waste water treatment systems that use the natural water-cleaning abilities of aquatic macrophytes were developed. To further develop this method and to determine the appropriateness and possibilities of such systems in Slovenia, we began setting up constructed wetlands at the end of the 1980s. Our goal was to determine the efficiency of treatment with constructed wetlands and to help improve the quality of Slovenia.

Possibilities for Constructed Wetland Usage in Slovenia

Based on the size of communities, organisation of sewerage systems, conditions of the present wastewater treatment plants, specific characteristics of individual geographical regions and economical situations, numerous possibilities can be found in Slovenia where building of constructed wetlands would be reasonable.

Slovenia is a relatively scarcely populated country with a density of 93 inhabitants/sq. km (1988). The majority of communities have populations of fewer than 500 inhabitants. Since constructed wetlands are primarily suited to smaller communities (100-1,000 people), it appears Slovenia is well suited for this alternative wastewater treatment method.

About 400 communities (totalling 140,000 inhabitants) are equipped with sewerage systems but do not have water treatment systems. By one accounting, only 25% of all wastewater from 134 communities undergoes wastewater treatment. Only half of all wastewater in Slovenia is treated in a mechanical-biological process.

Of the 120 conventional wastewater treatment systems in Slovenia, 97 of them have low loading rates, handling the wastewater needs of fewer than 1,000 people.

Constructed wetlands require land. In Slovenia, 93% (1988) of the land is not utilized, and only about 5% is urbanized. The present and planned constructed wetlands would in a few years cover only a few hectares, which is negligible.

Slovenia can be divided into several regions each with its own specific characteristics and problems concerning water management and wastewater treatment.

The Karst area, with its lack of water, stony ground and mild winters, is suited to constructed wetlands wastewater treatment. The wetlands could be made in the present canal system; the water retained in the wetlands could be used in multiple ways such as for fighting fires, watering cattle, irrigation and aquaculture.

In the lowlands, created wetlands for tertiary treatment could improve the poor water quality that has resulted from disorganised residential, industrial and agricultural wastewater practices.

In the mountainous Alpine area of Slovenia, communities are far apart and do not have sewerage systems connected to treatment plants. And during tourist season, numerous campsites release wastewater into freshwater reservoirs and lakes. Constructed wetlands are ecologically and economically justified in this area.

In the coastal region of Slovenia, along the Italian border, increased development of tourism has caused great demand for efficient wastewater treatment and protection of drinking water and lakes.

Small industrial companies in Slovenia are quite scattered. Since the expenses are high and an unfavorable economic situation exists in Slovenia, companies and communities are not able to use expensive conventional methods of treatment. They are forced to look for cheaper, alternative solutions.

Constructing the Wetlands

In 1989 we started basic and applied research of constructed wetlands. Using model and pilot systems, we studied the hydraulic characteristics of individual mixtures of substrata and water flow in the system. We also monitored physical-chemical variables of the influent and effluent and determined processes which played significant roles in the water treatment process.

Different combinations of macrophytes (*Schoenoplectus lacustris, Phragmites australis, Carex gracilis, Juncus inflexus, Juncus effusus*) were used. Using biological parameters (vertical, horizontal growth, dry weight of underground and upper parts, leaf index) and by analysing deposition levels of heavy metals, N and P into the underground parts of *Phragmites australis*, we tried to determine the efficacy of macrophytes in wastewater treatment.

Since 1989 we have constructed 7 pilot constructed wetlands which are used for different types of wastewater, including sewage from the central conventional treatment plant, dyed wastewater from food processing industry, communal wastewater and landfill leachate. We have tried to determine the

efficiency of constructed wetlands for treating different types of wastewaters.

The installation of constructed wetlands was not merely an experiment as it was carried out by taking into account the possibilities offered by the communities and companies involved. Improvements were made with each newly planned constructed wetland. For example, efficiency was increased by using different plant species and plants which had already been adapted to wastewater, by using various depths, substrata mixtures, bed systems, surface and depth water flow through the system and by constructing barriers. Innovations were also often incorporated into existing constructed wetlands after they were put into operation because sometimes unpredictable difficulties appeared.

These wetlands were planned and constructed in Slovenia during a period of great economic changes, and so changes in the hydraulic and organic loads of influent wastewaters from companies to the constructed wetlands were frequent. In some cases, companies were changed to such an extent that no wastewater at all was produced. In spite of all, we monitored all constructed wetlands to evaluate their efficiency and application.

Performance of Constructed Wetlands

The efficiency of the constructed wetlands confirmed our expectations. However, variations for different parameters on individual constructed wetlands were observed. The highest efficiency for BOD_5 and COD removal was 91% at two of the seven sites; the lowest was 45%.

Gradisce. Sewage and dyed wastewater from food processing industry.

For ortho-phosphate, the removal rates ranged from 52% to 96%. However, only long-term monitoring will show the actual efficiency over time, as we attribute high reduction primarily to the starting role of the unsaturated substrata.

Individual constructed wetlands varied considerably with regard to the the removal efficiency of ammonia, nitrite and nitrate content, ranging from 40% to 93% removal.

Against our expectations, the efficiency in reducing suspended solids in our constructed wetlands is low.

All constructed wetlands are capable of balancing pH levels, while dissolved oxygen content, compared to influent values, increases only in some constructed wetlands. The efficiency of the constructed wetlands is not considerably lower in winter.

Results of our microbiological analyses clearly demonstrate that the reduction efficiency of microbiological parameters increases with maturation of the system. Except for the leachate system, the required effluent standards for outlet into rivers have been achieved.

Measurements of biological parameters showed that the productivity of all chosen macrophytes was high. The choice of plants was adapted to each constructed wetland. The most efficient combination of macrophytes proved to be *Phragmites australis, Carex gracilis* and *Juncus effusus*.

Of course there were problems. The systems were at some sites damaged by strong winds, drought and sheep. There were no problems with surface flow except in one site where the choice of substrata was incorrect. There also were no problems with expansion of weeds in the constructed wetlands. Problems were caused by blocked pipes, frozen water in some valves, and problems caused by changes in hydraulic and organic loads in wetlands that had been constructed for different rates.

Conclusion

Results of our research show that constructed wetlands provide an efficient alternative method of wastewater treatment in Slovenia. However, further development to increase its efficiency must be carried out. Also, further detailed analysis of the constructed wetlands should be carried out after three years when the whole system has reached a mature state.

In Slovenia, there are many possibilities for planning and constructing such systems. Constructed wetlands to treat wastewater from conventional central treatment plants for secondary and tertiary treatment is reasonable, but constructed wetlands should be widely used, not only to protect areas with landfill leachate, communities and industrial areas, but also lakes, water sources, rivers, tourist attractions, national parks, reservations, Karst phenomena and areas along the highway network.

With regard to Slovenia, we believe the possibilities for constructing such systems are numerous and reasonable.

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AQUAPHYTE

This is the newsletter of the Center for Aquatic Plants and the Aquatic Plant Information Retrieval System (**APIRS**) of the University of Florida Institute of Food and Agricultural Sciences (IFAS). Support for the information system is provided by the Florida Department of Environmental Protection, the U.S. Army Corps of Engineers Waterways Experiment Station Aquatic Plant Control Research Program (APCRP), the St. Johns River Water Management District and UF/IFAS.

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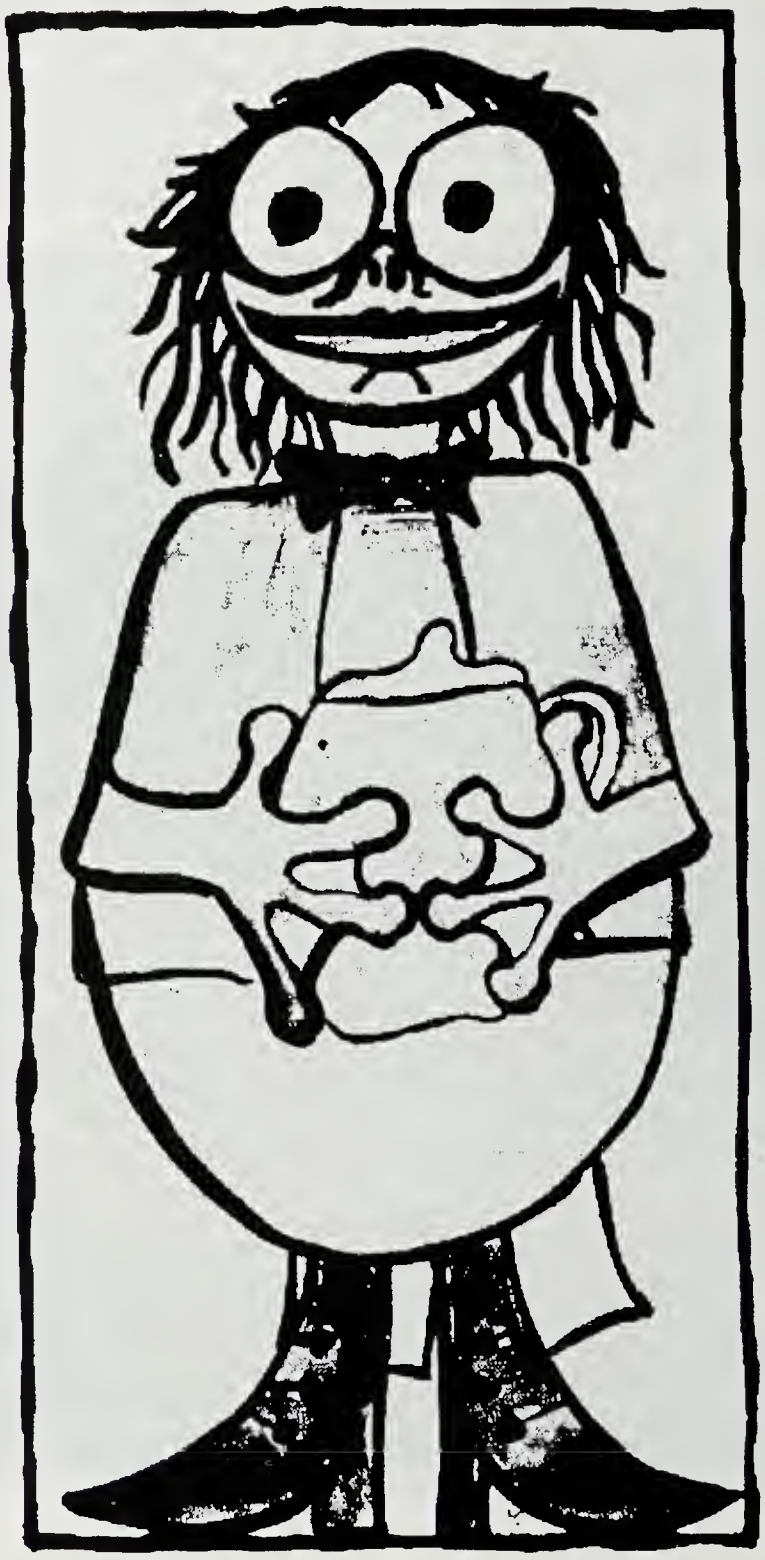

"Vodnik"

Who is this creature? Meet "Vodnik" or "waterman", a water sprite from Slavic folktales and legends, known to every child in the Czech Republic.

Vodnik (voda=water) lives in lakes, rivers and fishponds, often near mills. He can be good, visiting with people and having fun with them, or he can be evil, luring people into lakes and ponds and drowning them. He collects human souls and keeps them in special cups with a cover (pictured).

He is traditionally pictured as a green man with perpetually wet coat-tails. A popular traditional character, Vodnik has roles in Czech classical music and literature.

Drawing by Jitka Klimesova, Trebon, Czech Republic. Used with permission.